Metadata schema and mapping service for FIB/SEM serial-sectioning and x-ray computed tomography

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Introduction & Problem Statement

Tomographic methods utilizing various physical principles across different length scales are well-established techniques in Materials Science and Engineering (MSE). Prominent methods include computed tomography through x-ray and electron transmission imaging, focused ion beam serial sectioning, and atom probe tomography. A significant challenge in research data management within this field is that data acquisition is only one segment of the entire experimental workflow, which starts with sample preparation and concludes with the reconstruction of a 3D model (see Fig. 1). This complexity leads to several issues when considering data reuse, namely:

- The workflow from preparation to acquisition and reconstruction of a tomography dataset uses diverse tools
- Metadata are typically not carried over, leading to acquisition parameters no longer being connected to the reconstructed volume data
- Metadata is stored in different formats without a common standard

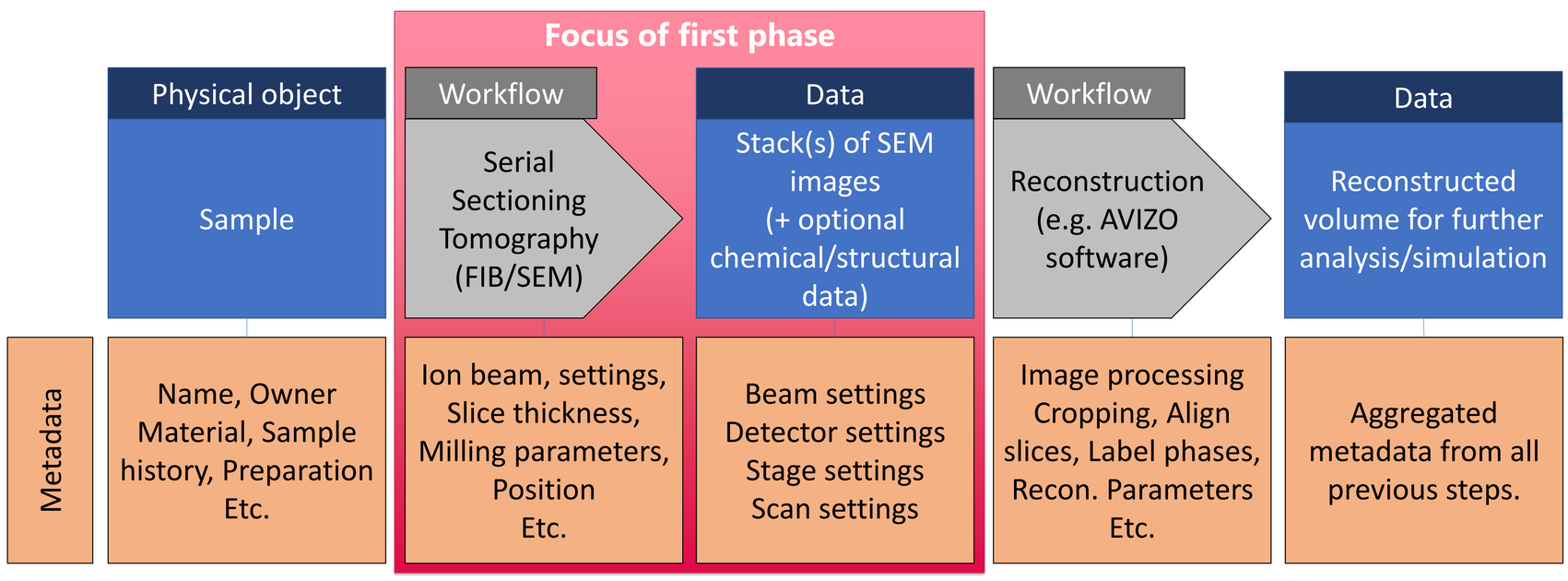

***Fig. 1**: Schmatic representation of a FIB/SEM tomography from sample to reconstructed volume. Sample, data, acquisition process and post-processing all come with their own, isolated metadata.*

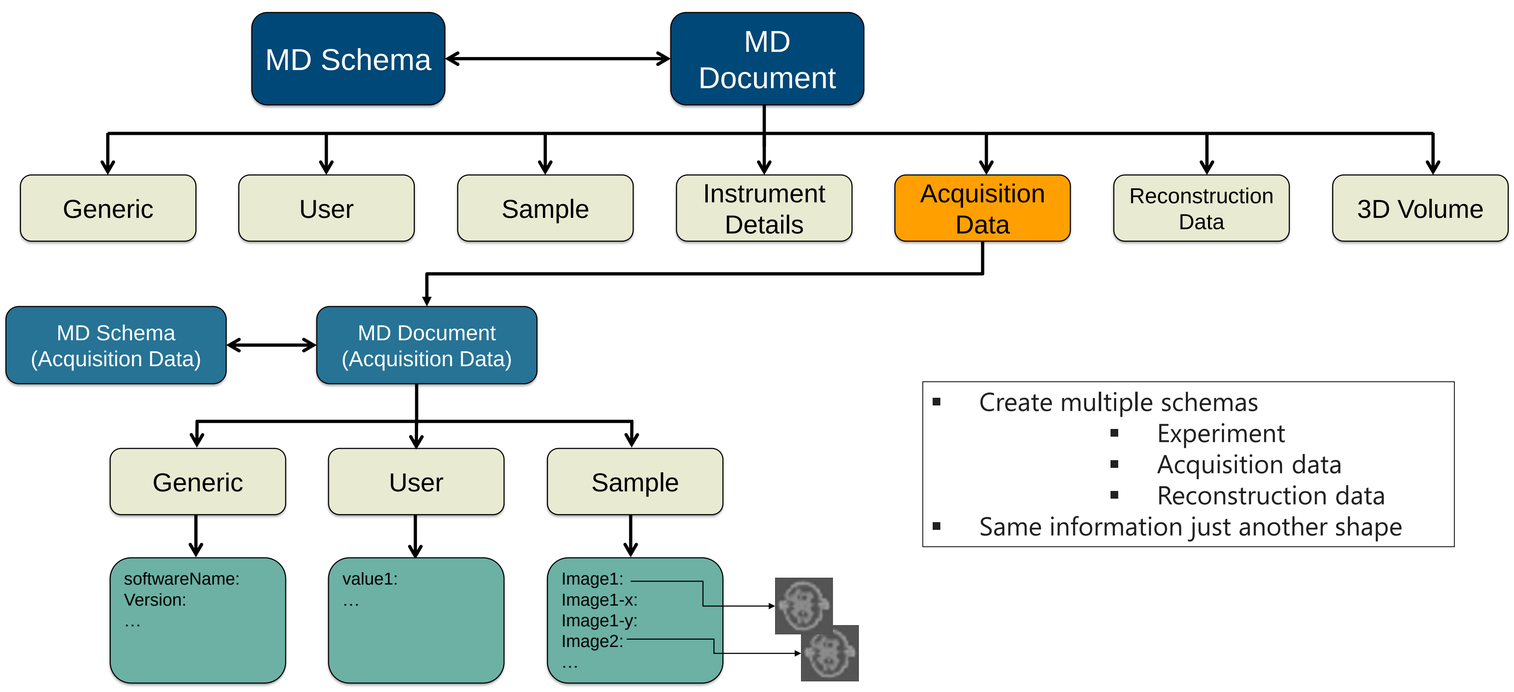

***Fig. 2**: Schematic representation of the nested metadata schema for a serial sectioning tomography with a focus on the acquisition process*

The approach

- In a first step, we collect metadata from the imaging and acquisition process scattered across different files
- Using a nested metadata schema (Fig. 2) and automatic extraction, a single metadata object is created
- Accessible as a web tool (or locally via Docker)
- The collected metadata can be used to visualize the evolution of instrument parameters (Fig. 3)

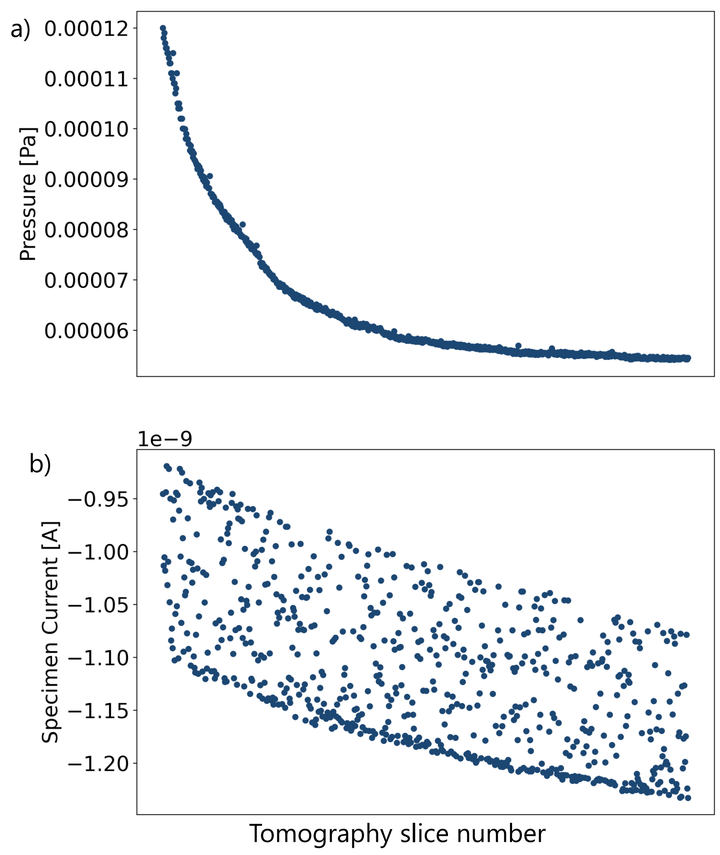

***Fig. 3**: a) Chamber pressure and b) specimen current versus SEM image number (715 images in this example)*

Conclusion

- Metadata from several hundreds of tomography slice images and from project files can be automatically harvested
- Metadata are arranged in a nested schema representing the acquisition process and building upon the schema for single SEM image files
- Generally applicable to other tomographic techniques, e.g. x-ray CT (in development)
- A user-friendly GUI provides a minimal entry barrier for the user
- A single JSON file is generated and can serve as a data source itself, e.g. for the evolution of instrument parameters over time
- Further steps include the extension to the reconstruction process

Find the mapping service online!

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